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AUTHOR Torrence, David R.
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ABSTRACT

The effects of smoking on test taking were assessed during administration of the International Union of Elevator Constructors' certification instrument to 95 subjects on June 7, 1986, at the Teamster's City in Chicago. The experiment was designed to determine whether smokers were slower in performing the mental activities required for taking the test. It appears that the observed differences between smokers and non-smokers in the time required to complete the examination was a random event. Moreover, there was no relationship in the time required to take the examination and examination score. There was, however, a slight difference between smokers and non-smokers in their performance scores. A review of the literature suggests that smokers who have been taught in an environment that allowed smoking or have smoked while studying for the examination should be allowed to smoke during examinations. Hence, it appears that barring smoking during administration of such examinations may be discriminatory. (TJH)

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by

David R. Torrence, Ed.D.
Staff Assistant for Instructional Development
National Elevator Industry Educational Program
21 Park Street, Suite 202
Attleboro, MA 02703

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IMPACT OF SMOKING ON TEST TAKING

Instructional Development Technical Report

Number 14

September 1, 1987

Prepared by David R. Torrence, Ed.D.
Staff Assistant for Instructional Development
National Elevator Industry Educational Program
21 Park Street, Suite 202
Attleboro, MA 02703

IMPACT OF SMOKING ON TEST TAKING

Background:

At a Mechanics Examination administration, the Journeymen level International Union of Elevator Constructors' certification instrument, conducted for Local #2, Chicago, ninety-five (95) of the scheduled ninety-nine (99) sat for the examination. It was administered on Saturday, June 7, 1986 at the Teamster's City in Chicago. The facilities at the examination site were spacious, clean, and well-lighted. Modern desk-chairs were rented for the occasion; and were arranged in two groups in the Teamster's large meeting room. The two groups of equally spaced chairs were facing each other; separated by a large open aisle.

To facilitate the smokers and nonsmokers, an informal show of hands suggested that about half the group were smokers and half were nonsmokers. The smokers were assigned to one group of chairs and the nonsmokers to the other to provide some separation. The air-conditioning system provided adequate ventilation for the room. As the examinees completed the exam and submitted their work, it became apparent that the nonsmokers were completing the exam at an observably greater rate. At one point, all but the last nine of the nonsmokers had left the room before the first of the smokers completed the exam.

Both a union official and an industry representative

responding to the obvious difference in completion rates posed the question: Were smokers actually slower in performing the mental activities required for taking the test? As the N.E.I.E.P. educational representative, I was hard pressed to give a research or data-based answer. I proposed to provide a response to this inquiry by conducting an experimental research study (per Campbell and Stanley, 1963) to provide a satisfactory answer.

Hypotheses:

The question that arose is based on the assumption that the observations were accurate. A priori reason requires an answer to the question: Was this a random observation or did the smokers take a significantly longer amount of time to challenge the examination? If so, are smokers actually slower in performing the measurement tasks? The performance instrument is a 160 multiple-choice item examination written at the knowledge, comprehension, and application taxonomic level in the cognitive domain.

The implication in the time differential is the suggestion that one, those who complete the examination early have higher (better) scores; and two, there is a differential in performance between smokers and nonsmokers. This is a generally held but questionable assumption. An activity to substantiate or reject this assumption as well as a measure of performance differentiation would be necessary to adequately answer the original question.

To examine these questions, three hypotheses were formulated

in the null form for statistical purposes:

- H1 There is no significant difference in the time required to take the Mechanics Examination between smokers and nonsmokers.
- H2 There is no significant differences in performance scores between smokers and nonsmokers.
- H3 There is no significant relationship between time and "Goodness" of score.

Research of relevant literature:

An ERIC search of the literature found few citations under the search headings: smoking, testing, job performance, and memory. The Sociological Abstracts found several performance effects of smoking marijuana, stress correlations with smoking, and smoking clinic evaluations; but little directly related to test performance or job performance and smoking. See Appendix A for the ERIC abstracts.

In a study by Gonzales and Harris (1980), smokers participated in an experiment assessing the effects of smoking or abstinence on immediate and delayed memory of new and old words, as well as category clustering. Subjects were divided into smoking and nonsmoking groups. Subjects in the smoking group showed significantly poorer immediate and delayed recall of old words and less clustering of words into categories on the delayed recall test.

Stevens (1976) found that tobacco smoking may have a deleterious effect on the learning process. Students who smoked in excess of 12 cigarettes per day did significantly less well,

as a group, than nonsmokers and light smokers on three of four learning tests. This suggests that a possible quantitative chemical effect may be measurable. Sappanen, Hakkinen and Tenku (1977) studied the effect of gradually increasing carboxyhemoglobin saturation in human visuoperceptual and psychomotor performance between smokers and nonsmokers. They found no significant difference in performance between the groups when exposed to air breathing or carbon monoxide gas breathing interventions. The smokers were found to have adapted to higher levels of carbon monoxide levels in the blood.

While pursuing research for writing an instructional unit on drug and alcohol abuse, citations regarding studies of tobacco as an addictive drug suggests that there is no indication that the drug impairs the performance of its users. In fact, there were inferences of studies that suggest use of tobacco by those addicted produce a relaxation reaction to the point that their performance on manual dexterity measures and low level mental computations are actually enhanced (Encyclopedia of Psychoactive Drugs, 1986).

The effects of 4 cigarettes of varying nicotine and tar level yields on the performance of a rapid information-processing task were tested. Not only did smoking help to prevent the decrease in speed and accuracy that occurred over time in the nonsmoking conditions, but it actually improved performance over base-line levels (Wesnes and Warburton, 1984).

Kunzdorf and Wigner (1985), in a 2 X 2 factorial design of

32 smokers who smoked an average of 15.2 cigarettes per day, found that memory was better than when study and testing were conducted in different states. It was concluded that smoking tobacco has a state-specific effect on smokers' memories. This has implications for test sites and policies that bar smoking.

The assumption that speed of response is highly correlated with the "goodness" of response is well documented in psychological literature (Spearman, 1927). This view, while widely held, has been challenged in the intervening years (Nunnally, 1967, p.560).

Procedure:

Data was collected through the Conduit Research Data response questionnaire. See Appendix B for a copy of the questionnaire. This is the data collection device used to gather information for research projects performed for the Conduit, the quarterly newsletter of the educational program. The data questionnaire was distributed to all the examinees of those examinations proctored by the author. In that proctoring assignment is random, it may be assumed that the data represents a random sample of all the examinees; therefore, a random sample of the industry's mechanics. In addition to other requested data, the CONRES data provided an examinee's response to whether he or she was a smoker or nonsmoker, his or her examination grade, and the start and stop time for the examination.

A total of 333 responses were tabulated in the "CONRES1" data program. See Appendix C for a computer printout of the complete file. In that two sets of data from two independent

groups are involved, a t-test was performed between smokers and nonsmokers on the measures of time and on performance scores. A summary of the results of the time required to complete the examination is shown in Table 1. A summary of the results of the performance scores is shown in Table 2.

Table 1
SUMMARY OF REQUIRED EXAM TIME

	Smokers	Nonsmokers
N =	151	181
Mean	3.2399	3.2174
S.D.	.5689	.5060
t = 0.288 < .10 at 330 d.f.		

Table 2
SUMMARY OF PERFORMANCE SCORES

	Smokers	Nonsmokers
N =	151	181
Mean	73.5133	75.9222
S.D.	7.1905	8.2949
t = 2.309 > .05 at 330 d.f. *		

Synonymous with this investigation was the assumption that those examinees that completed the exam earlier were also the high scorers. Most of the research upon which generalizations have been made were conducted among undergraduate and graduate students. This writer believes that it is important to investigate the suitability of the inferences to a non-

collegiate adult learner population. To substantiate this assumption for the examinees, a Pearson product-moment correlation was performed between the performance scores and the time of completion. Table 3 is a summary of the correlation between time and performance.

Table 3
*CORRELATION BETWEEN TIME AND PERFORMANCE

	Smokers	Nonsmokers
Smokers	-	.005
Nonsmokers	.005	-

$$r = 0.005 < .05 \text{ at } 331 \text{ d.f.}$$

Summary:

Using an independent t-test, no significant difference was found between the mean time of the smokers and the mean time of the nonsmokers; therefore we cannot reject the null hypothesis:
H1 There is no significant difference in the time required to take the Mechanics Examination between smokers and nonsmokers.

We must conclude that the observed difference at the Chicago exam site was not reflective of a difference that exists for the entire industry. The observed difference must have been a random event.

Using an independent t-test, a significant difference was found between the mean performance scores of the smokers and the mean performance scores of the nonsmokers. The measured t score was greater than the table t score at the .05 level but

less than the table t score at the .01 level of significance for 330 degrees of freedom (Arkin and Colton, 1968). We therefore can reject the null hypothesis:

H2 There is no significant differences in performance scores between smokers and nonsmokers.

We must conclude that, for the industry, nonsmokers perform better on the examination, on the average, than do smokers.

Using a Pearson Product-Moment Correlation between the measures of time and performance score, a low, nonsignificant correlation was measured. We therefore cannot reject the null hypothesis:

H3 There is no significant relationship between time and "Goodness" of score.

We must conclude that, for the industry's Mechanics Exam examinees, those who finish early score about the same as those who take a longer time to complete the exam.

Conclusions and Recommendations:

Questions arise with regard to the size of the real differences and their impact upon the industry. For instance: Is there a great difference in group performance or is the difference minor? Is there a significantly greater number of failures among the smokers than among the nonsmokers? Table 4 is a chi square table showing the computation of chi square to determine if a significantly greater number of smokers falls below the passing grade of 70 than do nonsmokers.

The percentage of smokers whose performance score is below 70 is not significantly different from the percentage of

Table 4
SUMMARY OF PERCENTAGE OF FAILURES

	Smokers	Nonsmokers
Estimated	52.5	52.5
Observed	57	50

$$\chi^2 = 0.171 < .70 \text{ at } 1 \text{ d.f.}$$

nonsmokers. We may infer that, while smokers' mean scores are lower, they do not form a unique group of poor performers. The median scores for smokers was 73.338 and the median score for the nonsmokers was 76.563. The frequency distribution shows no major bimodal bias or skew with either variable. See Appendix D for a frequency distribution of the data.

There are many psychological studies that suggest that smokers represent a unique grouping of personality traits. Smokers have been shown to be significantly different from nonsmokers on personality traits such as being more extroverted. One could make the hypothesis that smokers are more nervous and therefore possibly more spontaneous in their test taking performance which could account for several points.

One suggestion that has been forwarded is that the nonsmokers as a group may be biased toward the more intelligent; that is, those who intellectually make the decision to choose not to smoke or to stop smoking. It must be pointed out, however, that both the maximum score, 97, and the minimum score, 47, were obtained by nonsmokers. Nothing in the literature supports this position.

It is the most probable conclusion that the personality differences between the groups may account for the performance difference. Smokers may be more apt to be risk takers.

While there is a statistically significant difference in performance between smokers and nonsmokers, the measurable magnitude between the two groups is not great enough, relative to the external criterion, to identify one group as markedly or identifiably better than the other in performing the mental tasks required on the test. Smoking or nonsmoking as a characteristic of mental prowess would not be supportable to use as a criterion of entry level employment or promotion without research into the personality differences between the two groups and their usefulness or desirability within a job performance context.

To respond to any questions generated at the Chicago examination, it may be stated that, given the population of the examinees, the observed differences between smokers and nonsmokers in the time required to complete the examination was a random event in that there is no significant difference between smokers and nonsmokers in the time required to complete the examination; that there is no relationship between the time required to take the examination and the score; there is a difference between smokers and nonsmokers in their performance scores, but that the measured difference is not sufficient to categorize nonsmokers as "better" than smokers.

The review of literature suggests that smokers who have been taught in an environment that allowed smoking or have smoked

while studying for the examination be allowed to smoke during the examination. In light of this state-specific finding, barring smoking during the examination may be discriminatory practice.

These findings may be inferred to other non-collegiate, adult learners.

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Appendices

All Appendices included in the Technical Report are proprietary property of the National Elevator Industry Educational Program. While the data do not impinge upon any rights of privacy, they are not necessary for understanding the conclusions and recommendations of this presentation. The writer will provide any additional data relative to the Appendices for research purposes upon request.